From satellite images to population estimates

TeleCense

We help Companies, Authorities, International Organizations and Labs to assess and anticipate population growth and migration in emerging countries

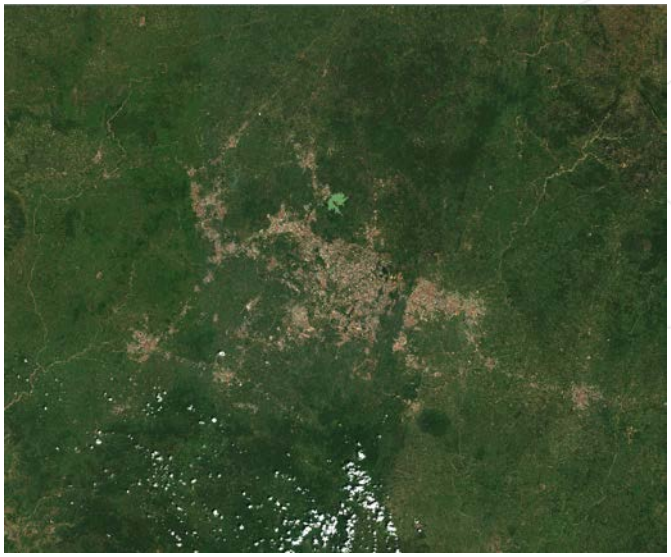
Diginove

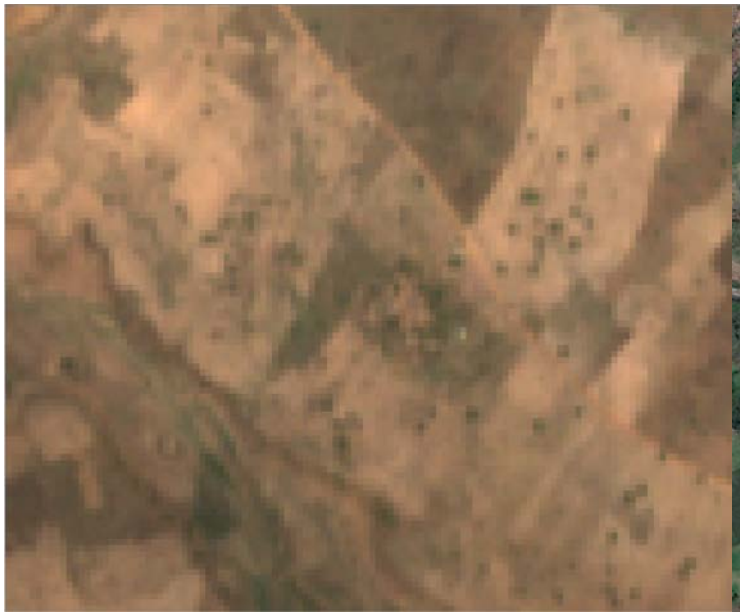
Telecense : overview

Goal : to provide over a geographic or administrative area :

- Footprint & built-up assessments
  - Using free satellite images from Copernicus
- Population estimations
  - Using demographic models, working with INED, LIED & e-Geopolis
- Evolution trends
  - Using machine learning algorithms over temporal series

Footprint & built-up assessments





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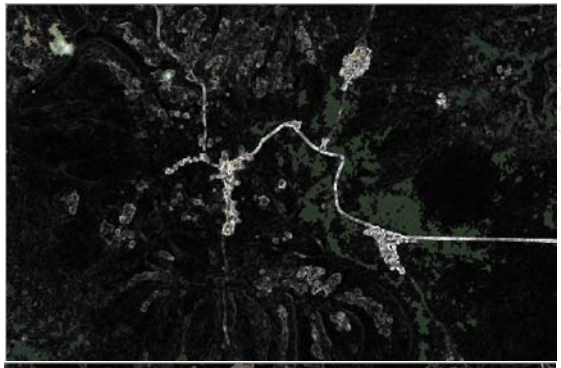
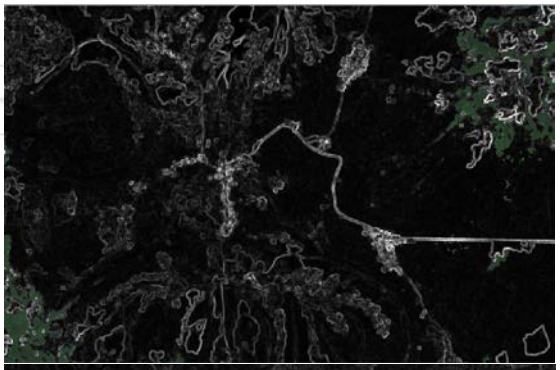
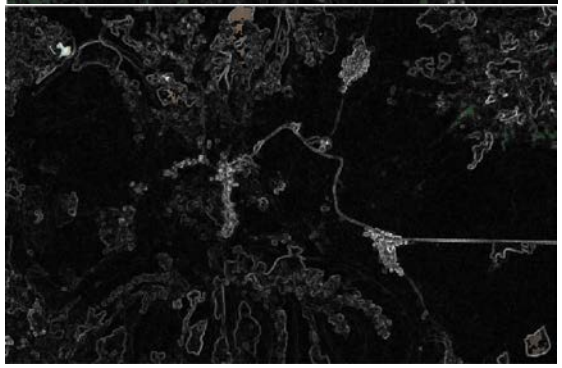
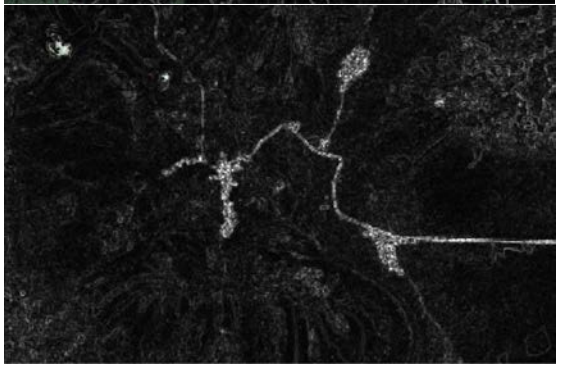
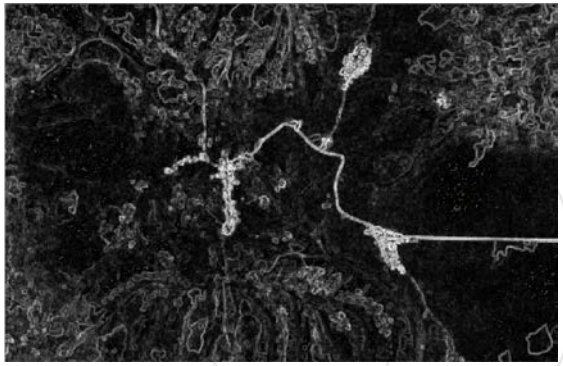


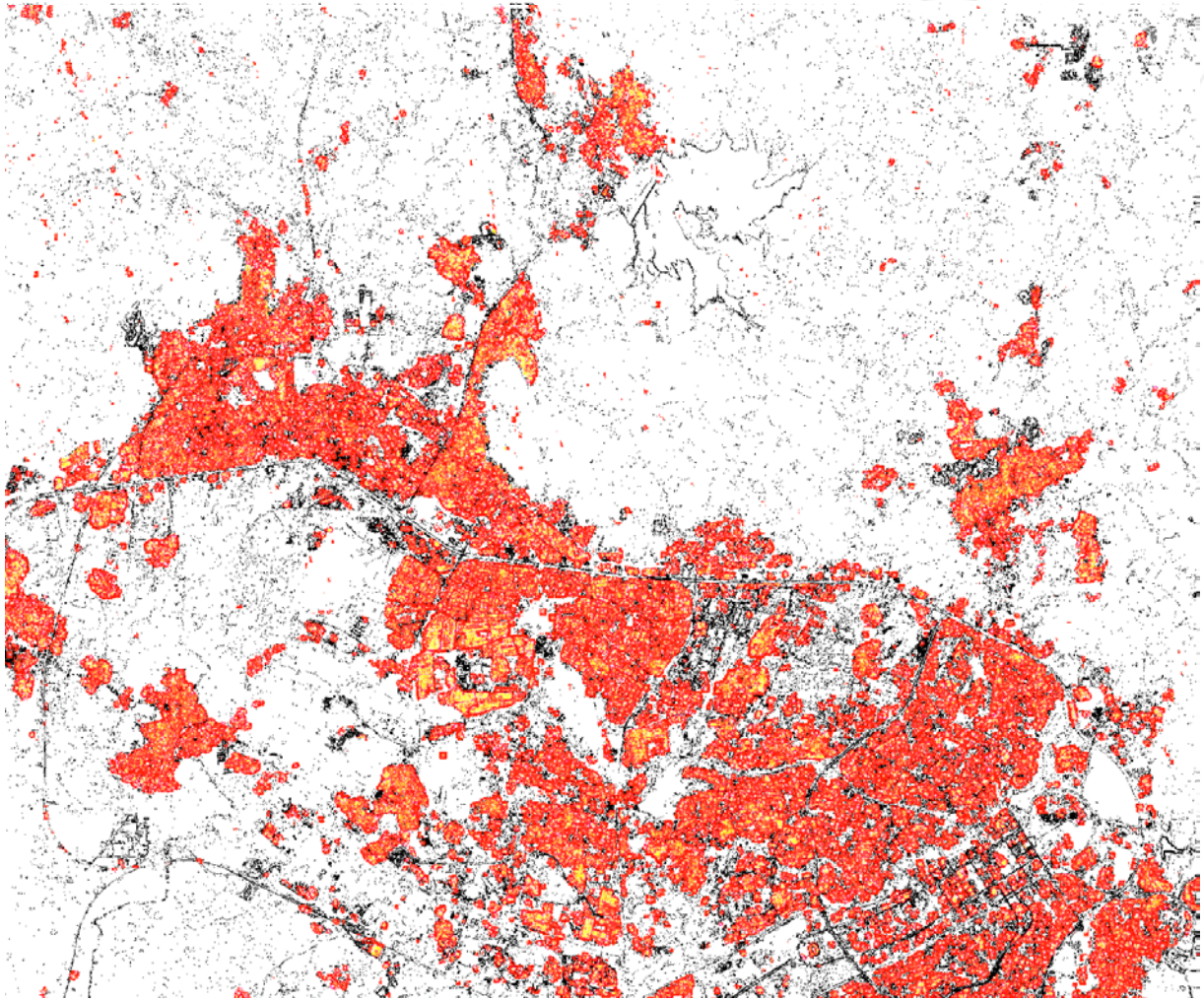








Footprint & built-up assessments



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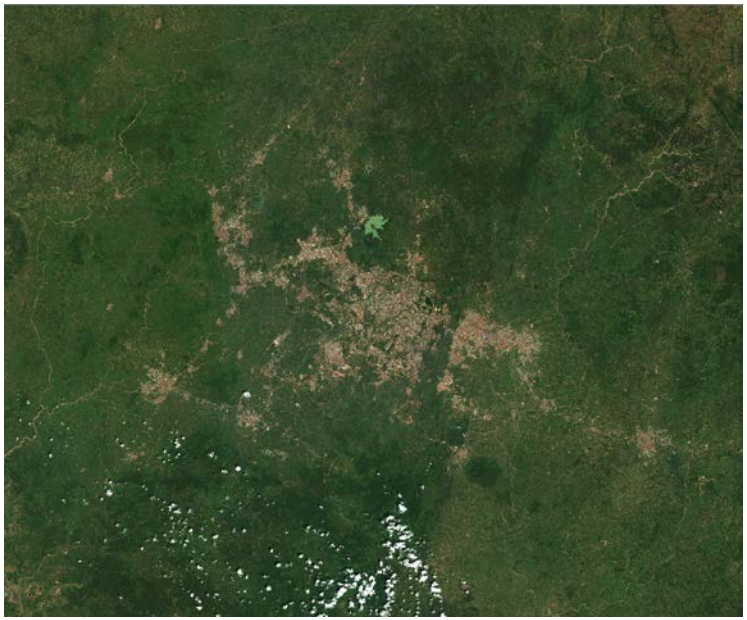
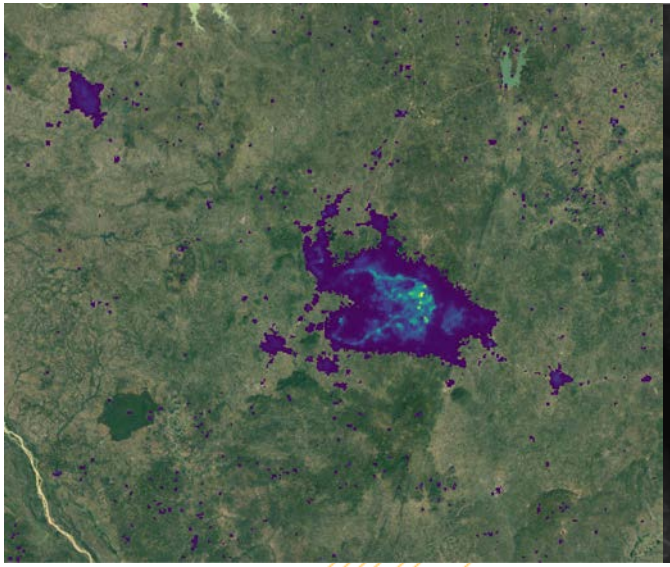
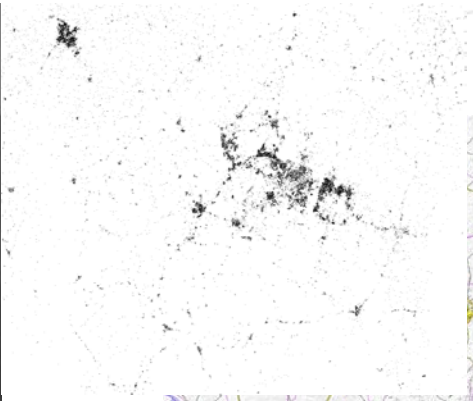
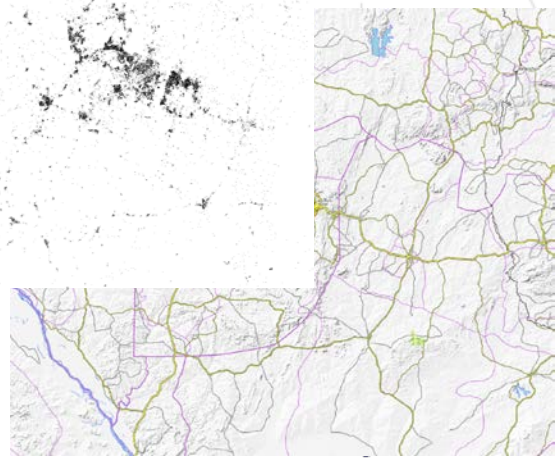




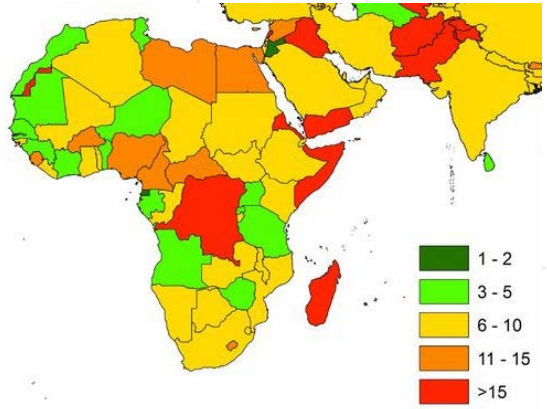




Footprint & built-up assessments

From building detection to population estimation

- Issue : Cencuses in Africa are
  - generally too old
  - Do not cover the rural part of the country



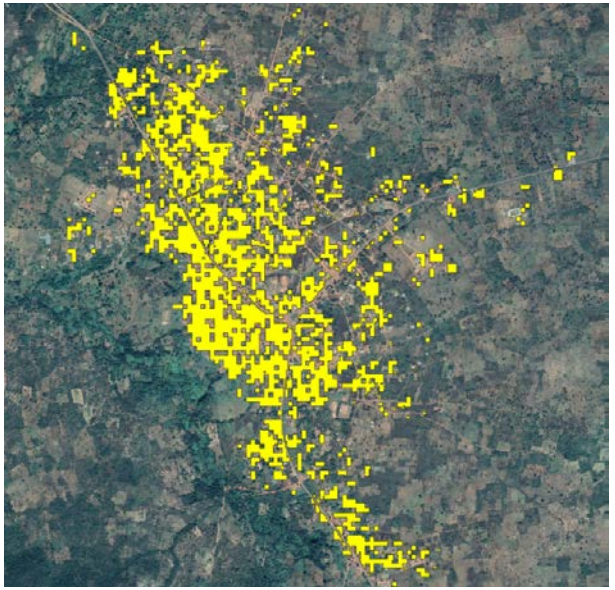
- Solution : use WorldPop / Grid3 data as population starting point
- Aim : Create demographic models to estimate the population of urban and rural areas in the abscence of census data.

Concept of agglomeration : our statistical unit

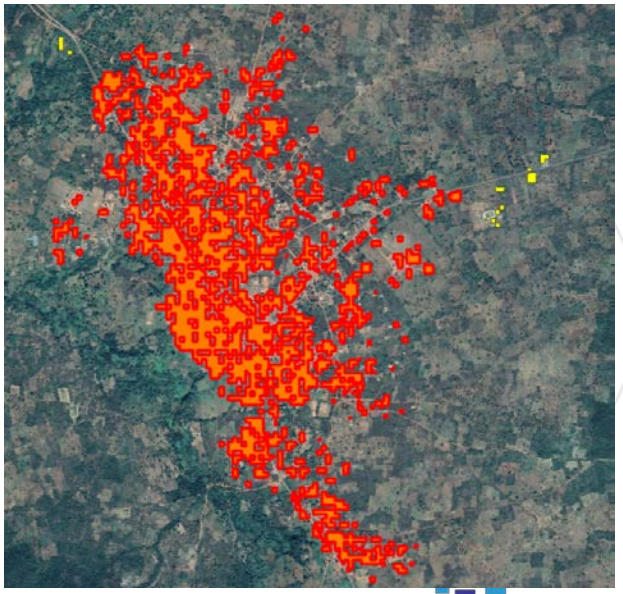
- **Single physical criterion** : built-up areas are joined and considered as an agglomeration if the distance between one area and another is less than 200m

1. ***Satellite images with built-up areas***

2. ***Built-up detection (Yellow)***



3. Creation of the agglomeration (red) according to the criterion of physical distance between zones

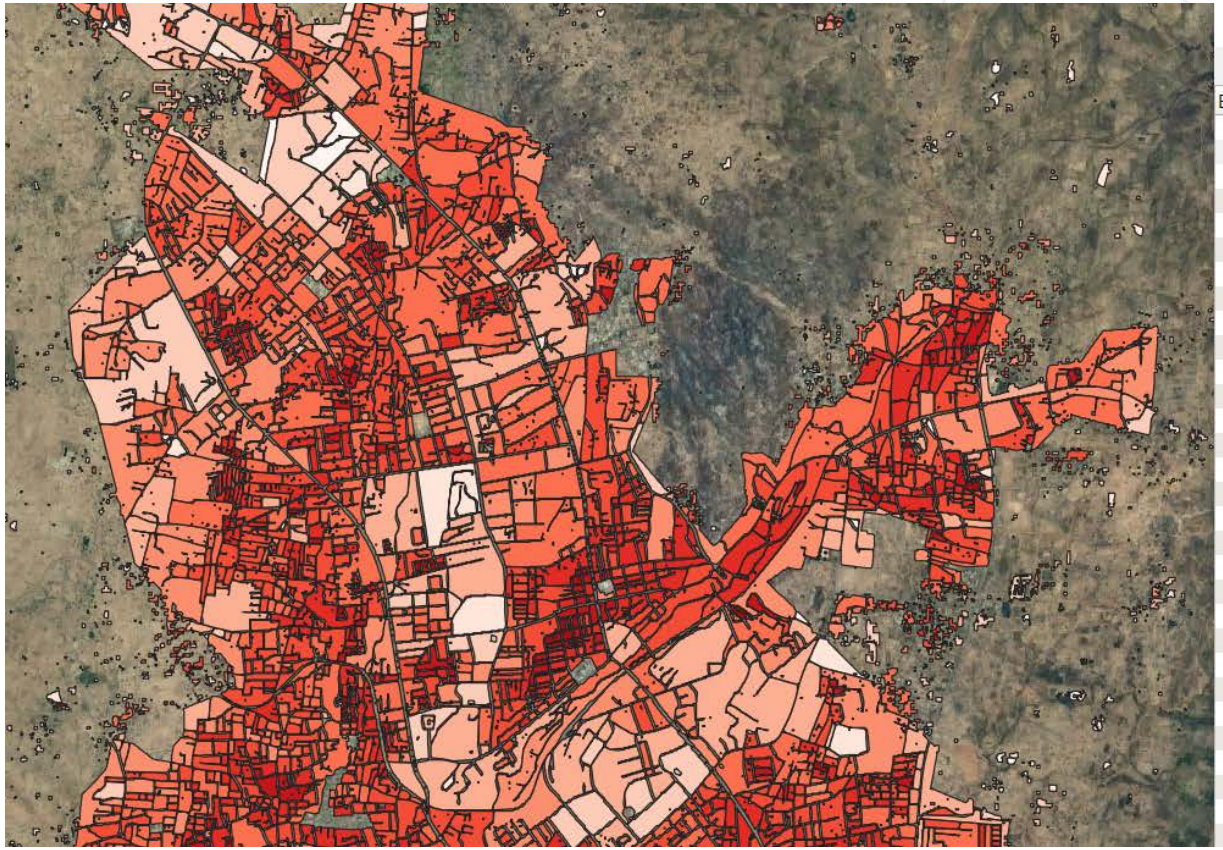


Cross-referencing of numerous data sources

- Censuses
  - Population / Migration
- Household surveys (DHS, EIM, MICS etc.)
  - Average household size / Age and gender distribution / Rural & urban distribution
- Remote sensing
  - Area / Number of shapes / Convexity indices (Solidity & Concavity) / Distance to Road, Water Point, Health Centre / Slope / Elevation / Building Density
- Other sources : e-geopolis / ESA …
  - Temperature / Precipitation / Light intensity at night (gives a probability of having electricity) / Mobile data

Example of an urban area in the Abuja region

- Each agglomeration has its own list of characteristics



Résultats de l'identification

Entité	Valeur
20200407-T32PKQ-T32PKR-T32PLQ-T32PLR-cities copier	
fid	10032
(Dérivé)	
(Actions)	
fid	10032
area	62149000
elevation	254
elevationMin	197
elevationMax	348
slope	0
width	14060
height	12430
perimeter	2629320
externalPoints	14
solidity	0,43
concavity	58,49
nbShapes	4747
BigCtyDist	0
BigCtyName	Minna
BigCityInd	799
Preci	1138,2056118920564
EcoRegion	Guinean forest-savanna mosaic
Temp	27,119116250874953
startelec	1999
EL2016MxT	0,9999961853027344
WPop2020	1442650
distanceToRoad	0
distanceToWater	0
distanceToHealth	0
administrative-bounda...	(2:5,7)

Typology and modelling based on agglomeration characteristics

- Typology of built-up areas :
  - Urban centres
  - Peripheral urban areas
  - Rural areas
- Population modelling by multiple linear regression :

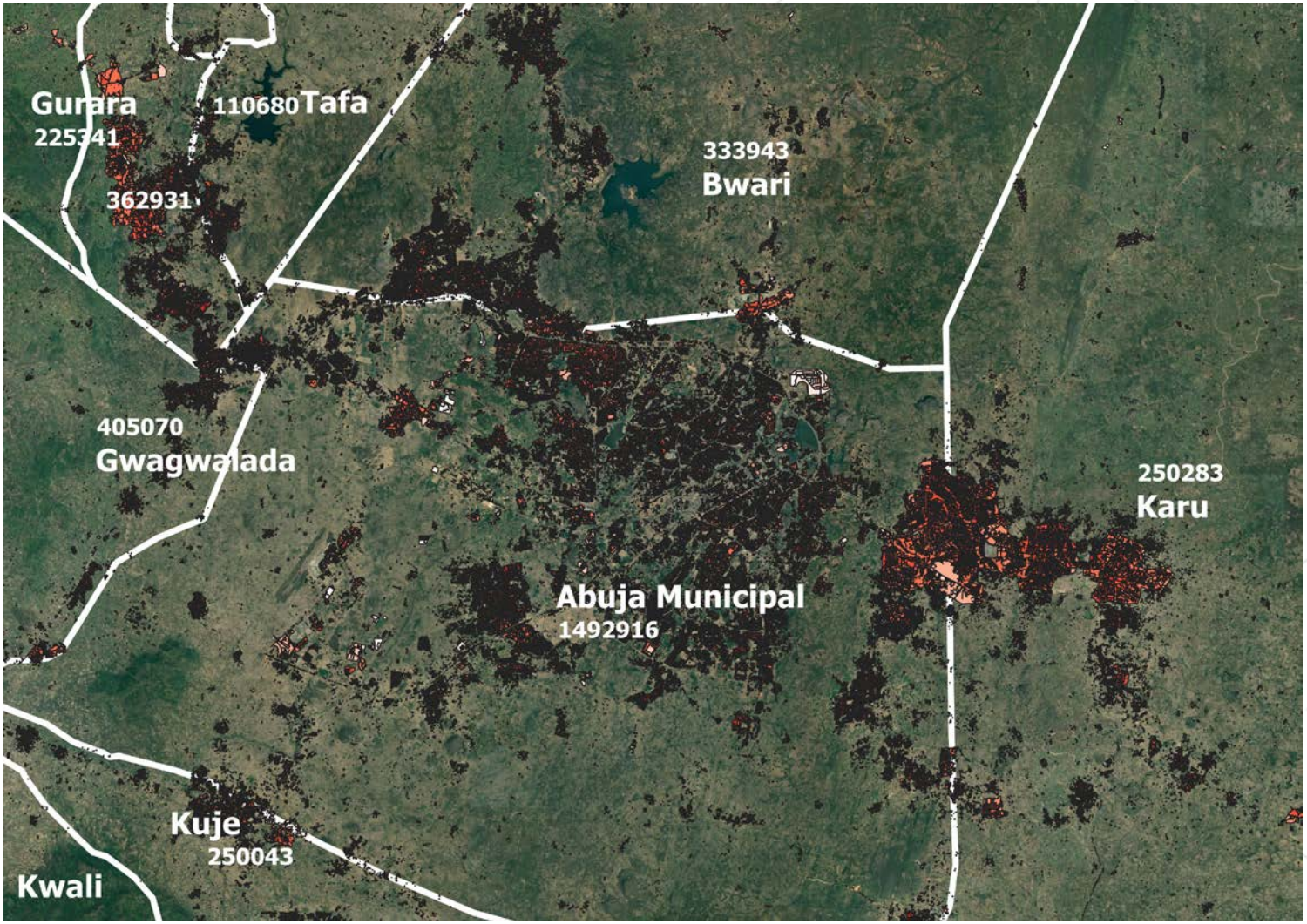
$$Population_{Agglo(i)} = \beta_0 + \beta_1 Aire + \beta_2 Elec + \beta_3 Concav + \beta_4 Largeur + \beta_5 Dist_{Health} + \beta_6 Dist_{Road} + \beta_7 Densite_1 + \beta_8 Densite_2 + \beta_9 Densite_3 + \beta_{10} Densite_4 + \varepsilon_i$$

- Adding spatial statistics :
  - Spatial autocorrelation
  - Spatial heterogeneity

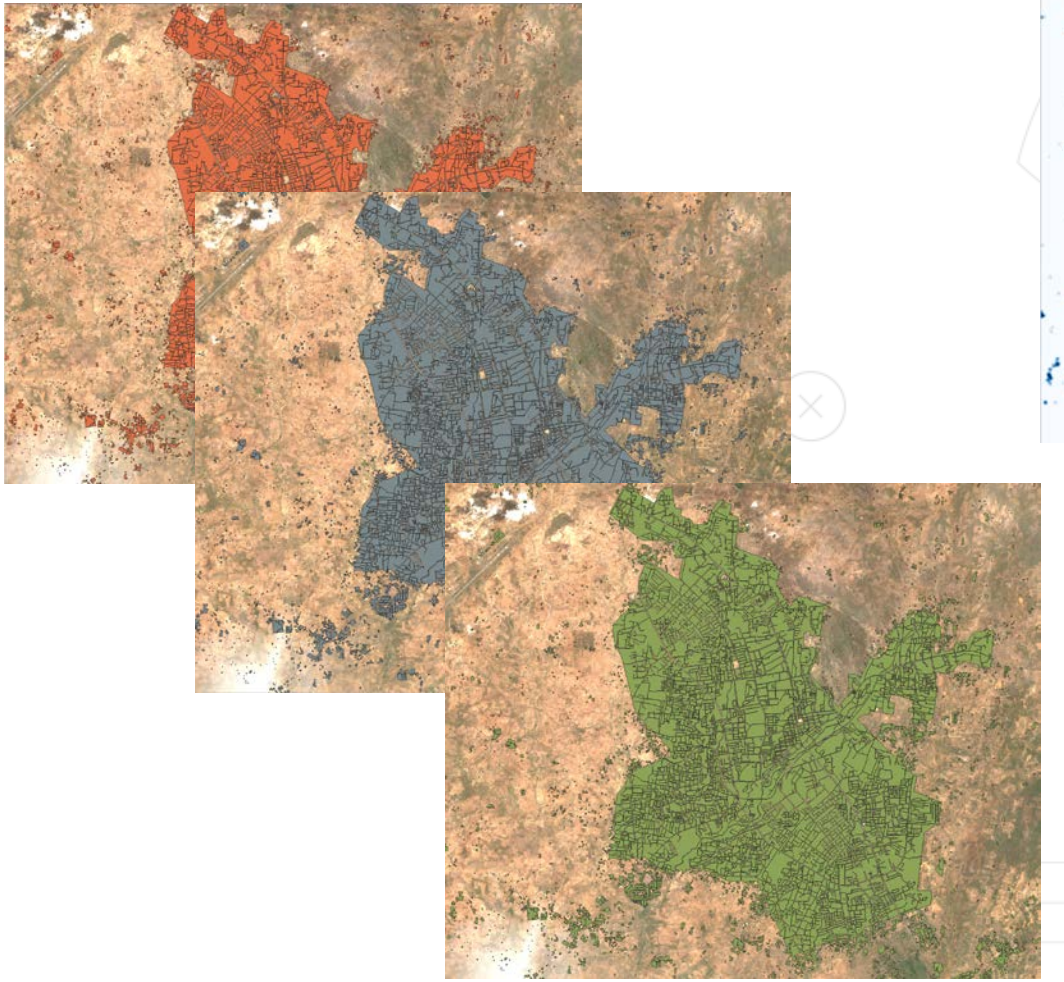
Once the demographic models have been created:

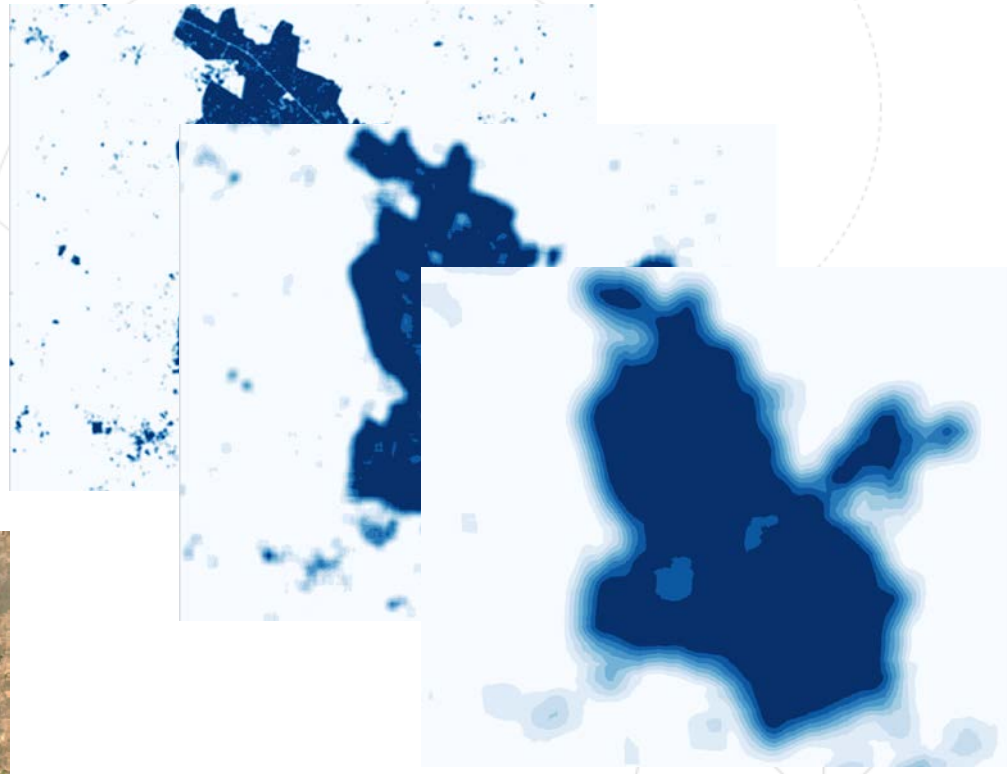
- Estimating the population of scattered settlements :

Abuja is divided into 6 administrative zones



Evolution trends





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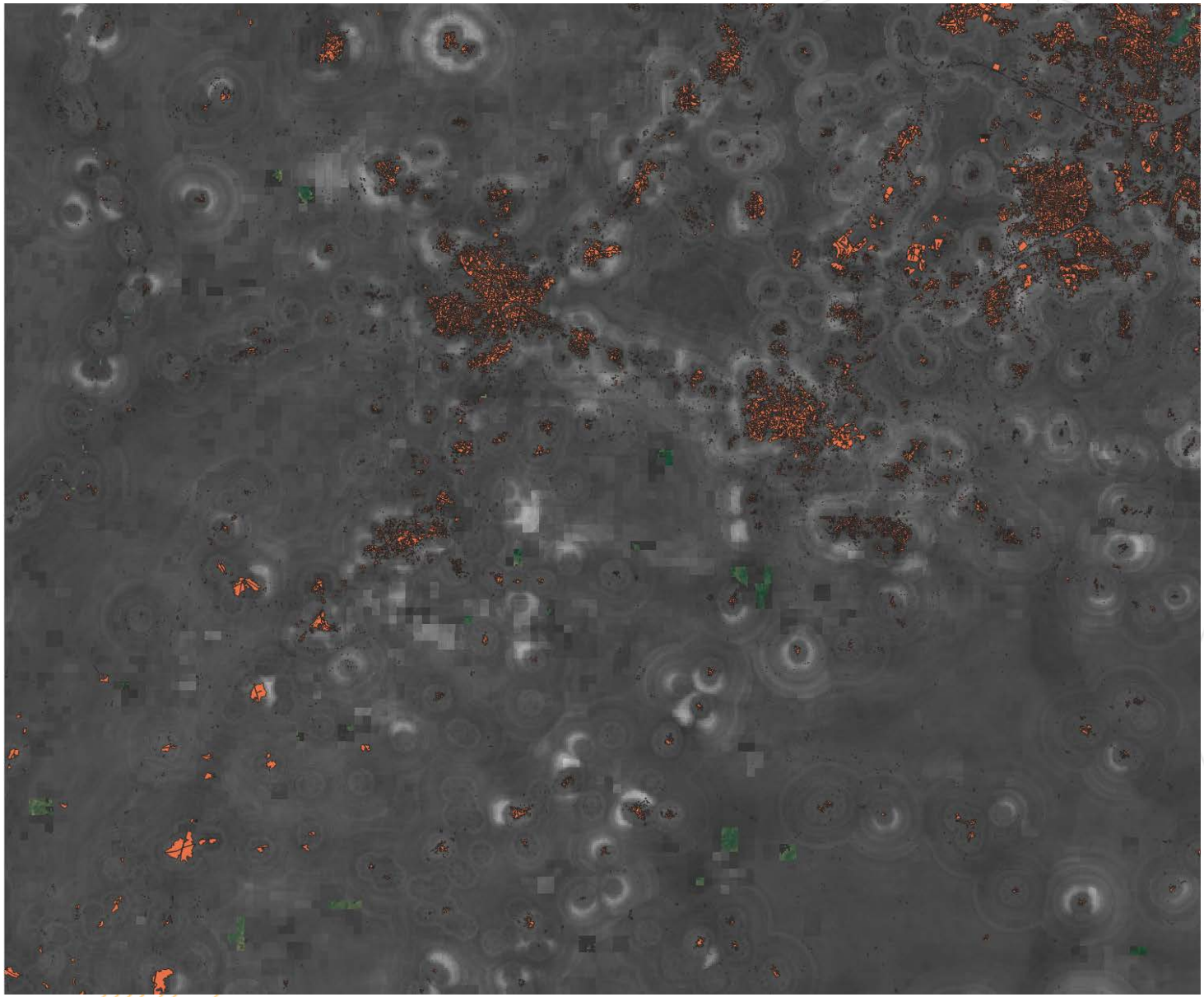
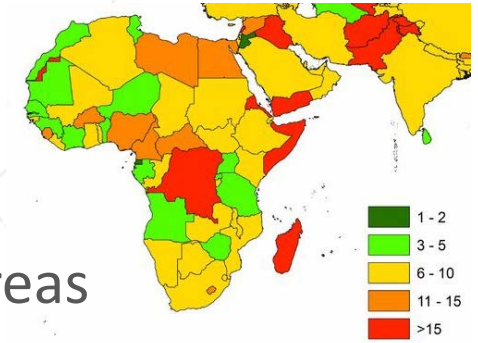


Main applications & advantages

- No need of previous census to estimate population



- Able to provide data on conflict or not accessible areas
- Reduce cost of the preparation phase of a census
- Anticipation thanks to regular updates & trends
  - Needs : schools, hospitals, transport, telecom
  - Public health, NGO, climate risks
  - Migrations
- Possibility to adjust the level of service on small areas :
  - Using VHR
  - Using expert validation for footprint & population estimates

TeleCense

Thank you !

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